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Lake Kemp
Baylor County, Texas

National Eutrophication Survey, Corvallis, Oreg

Prepared for

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Report

on

LAKE KEMP

BAYLOR COUNTY

TEXAS

EPA REGION VI

Working Paper No. 616

With the cooperation of the

Texas Water Quality Board

and the

Texas National Guard

March, 1977

TECHNICAL REPORT DATA

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16. ABSTRACT:

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN-ENDED TERMS	c. COSATI Field/Group
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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGEMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Texas Water Quality Board for professional involvement, to the Texas National Guard for conducting the tributary sampling phase of the Survey, and to those Texas wastewater treatment plant operators who voluntarily provided effluent samples.

Hugh C. Yantis, Jr., Executive Director of the Texas Water Quality Board, and John B. Latchford, Jr., Director, and the staff of the Field Operations Division provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

Major General Thomas Bishop, the Adjutant General of Texas, and Project Officer Colonel William L. Seals, who directed the volunteer efforts of the Texas National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

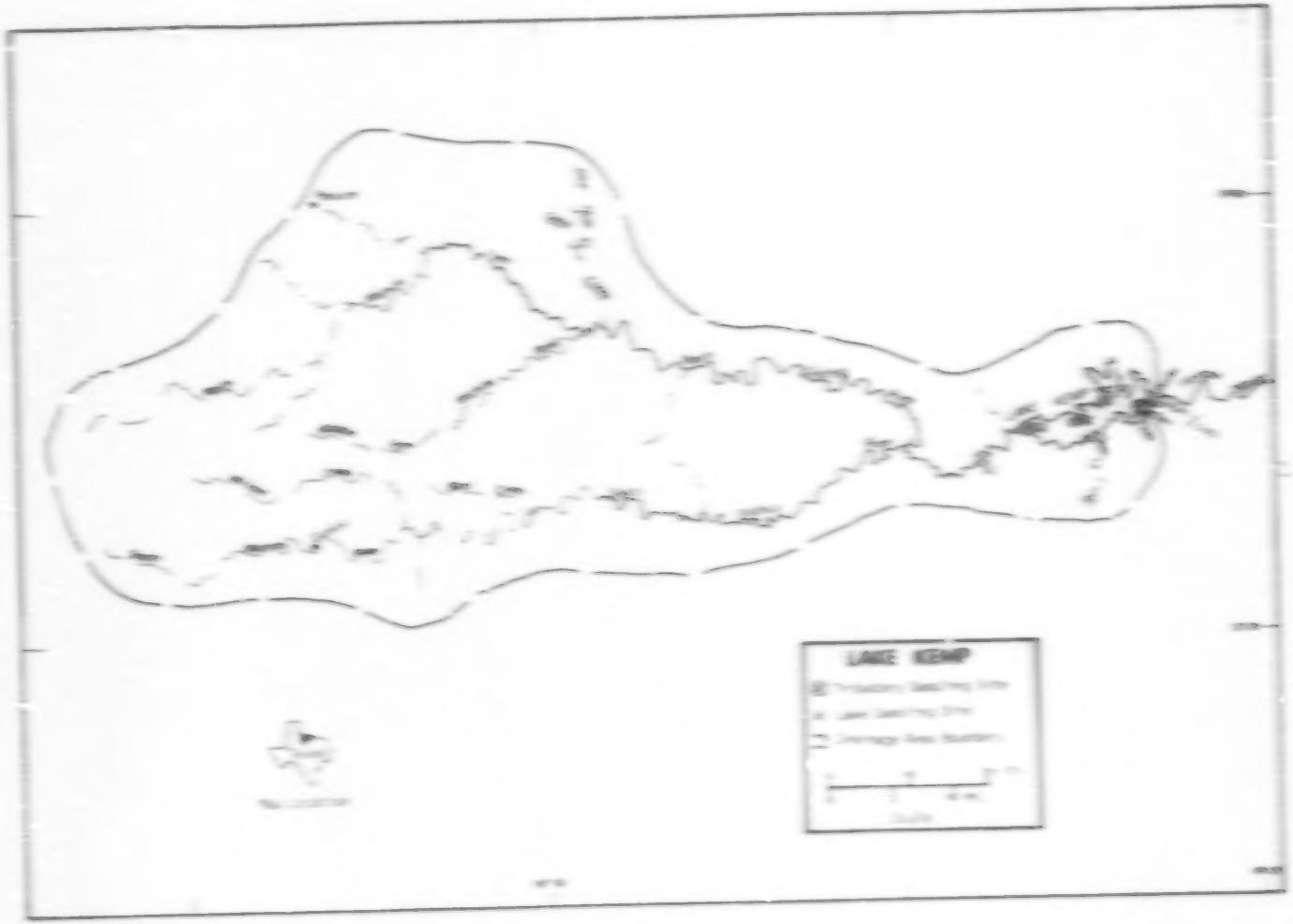
NATIONAL EUTROPHICATION SURVEY

STUDY RESERVOIRS

State of Texas

NAME	COUNTY
Amistad	Val Verde
Bastrop	Bastrop
Belton	Bell, Coryell
Braunig	Bexar
Brownwood	Brown
Buchanan	Burnet, Llano
Caddo	Harrison, Marion, TX; Caddo Parish, LA
Calaveras	Bexar
Canyon	Comal
Colorado City	Mitchell
Corpus Christi	Jim Wells, Live Oak, San Patricio
Diversion	Archer, Baylor
Eagle Mountain	Tarrant, Wise
Fort Phantom Hill	Jones
Houston	Harris
Kemp	Baylor
Lake O'The Pines	Camp, Marion, Morris, Upshur
Lavon	Collin
Lewisville (Garza-Little Elm)	Denton
Livingston	Polk, San Jacinto, Trinity, Walker

Lyndon B. Johnson	Burnet, Llano
Medina	Bandera, Medina
Meredith	Hutchinson, Moore, Potter
O. C. Fisher (San Angelo)	Tom Green
Palestine	Anderson, Cherokee, Henderson, Smith
Possum Kingdom	Palo Pinto, Stephens, Young
Sam Rayburn	Angelina, Jasper Nacogdoches, Sabine, San Augustine
Somerville	Burleson, Lee, Washington
E. V. Spence	Coke
Stamford	Haskell
Stillhouse Hollow	Bell
Tawakoni	Hunt, Kains, Van Zandt
Texoma	Cooke, Grayson TX; Bryan, Johnston, Love, Marshall, OK
Travis	Burnet, Travis
Trinidad	Henderson
Twin Buttes	Tom Green
White River	Crosby
Whitney	Bosque, Hill
Wright Patman (Texarkana)	Bowie, Cass


LAKE KEMP

LAKE KEMP

STORET NO. 4816

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Lake Kemp is eutrophic; i.e., well supplied with nutrients and quite productive. Whether nutrient enrichment is beneficial or deleterious depends on the actual or potential effect on the uses of the lake. In this regard, no nuisance conditions are known to personnel of the Texas Water Quality Board and there is little or no impairment of the designated beneficial uses of this water body.

Lake Kemp ranked fourth in overall trophic quality when the 19 Texas reservoirs sampled in 1974 were compared using a combination of six parameters*. Nine of the reservoirs had less and one had the same median total phosphorus, two had less and five had the same median dissolved orthophosphorus, 14 had less and two had the same median inorganic nitrogen, 17 had less mean chlorophyll a, and 17 had greater mean Secchi disc transparency. Moderate depression of dissolved oxygen with depth occurred at sampling stations 1 and 2 in August.

Survey limnologists noted turbidity due to suspension of red clay bottom materials in March and October. Blue-green algae were dominant in the August and October phytoplankton samples (page 8).

* See Appendix A.

B. Rate-Limiting Nutrient:

The algal assay results indicate that the lake was phosphorus limited at the time the sample was collected. The lake data indicated phosphorus limitation in March, May, and August but nitrogen limitation in October.

C. Nutrient Controllability:

1. Point sources--No known municipal or industrial point sources impacted Lake Kemp during the sampling year. It is estimated that septic tanks serving lakeshore dwellings contributed less than 2% of the total phosphorus load to the lake, but a shoreline survey would be necessary to determine the significance of these sources.

It is calculated that Lake Kemp received a total phosphorus loading of 0.20 $g/m^2/yr$. This is less than that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading but is more than his suggested oligotrophic loading (i.e., a mesotrophic loading; see page 14). However, U.S. Geological Survey records for water year 1975 (Anonymous, 1976) show the volume of Lake Kemp during the year was less than 60% of the conservation pool volume, so the actual areal phosphorus loading was greater than indicated.

2. Non-point sources--The phosphorus contribution of non-point sources accounted for about 98% of the total phosphorus load during the sampling year. The Wichita River contributed

over 83% of the total, and the minor tributaries and immediate drainage were estimated to have contributed about 6%.

The phosphorus export rate of the Wichita River was a rather low 2 kg/km^2/yr. This rate is comparable to the rates of unimpacted streams sampled elsewhere in Texas.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Morphometry††:

1. Surface area: 62.17 kilometers².
2. Mean depth: 5.3 meters.
3. Maximum depth: >13.1 meters.
4. Volume: 330.575 x 10^6 m^3.
5. Mean hydraulic retention time: 2.8 years (based on outflow).

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Wichita River	4,853.7	5.05
Immediate drainage -	486.8	0.37
Totals	5,340.5	5.42

2. Outlet -

Wichita River	5,402.5**	3.71**

C. Precipitation***:

1. Year of sampling: 70.6 centimeters.
2. Mean annual: 69.1 centimeters.

† Table of metric conversions--Appendix B.
†† Anonymous, 1976; surface area planimetered at conservation pool elevation (349 m).
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake; lesser outflow due to evaporation.
*** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Lake Kemp was sampled four times in 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two or more depths at three stations on the lake (see map, page vi). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first visit, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 13.1 meters at station 1, 10.4 meters at station 2, 1.8 meters at station 3, and 7.0 meters at station 4.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR [illegible] LAKE
STUDY CODE [illegible]

PARAMETER	1ST SAMPLING : [illegible]			2ND SAMPLING : 9/13/74			3RD SAMPLING : [illegible]		
	# STATIONS			# STATIONS			# STATIONS		
	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN
TEMP (C)	9.9 - 12.2	10.5	10.1	21.9 - 23.4	22.6	22.8	25.5 - 27.3	26.3	26.3
DISS OXY (MG/L)	10.2 - 10.8	10.4	10.6	7.6 - 8.0	7.7	7.8	4.6 - 8.2	6.6	6.8
CNDCTVY (MICROMO	366. - 438.	378.	378.	48. - 409.	256.	278.	534. - 540.	538.	536.
PH (STAND UNITS)	8.1 - 8.1	8.1	8.1	8.3 - 8.4	8.3	8.3	7.9 - 8.4	8.2	8.3
TOT ALK (MG/L)	94. - 104.	96.	95.	84. - 87.	84.	85.	83. - 92.	86.	86.
TOT P (MG/L)	0.006 - 0.012	0.009	0.009	0.025 - 0.124	0.035	0.023	0.037 - 0.046	0.025	0.025
SRTHO P (MG/L)	0.005 - 0.011	0.007	0.007	0.006 - 0.011	0.008	0.009	0.002 - 0.003	0.002	0.002
NO3+NO2 (MG/L)	0.678 - 1.110	0.896	0.896	0.006 - 1.220	0.138	0.138	0.003 - 0.038	0.021	0.021
AMMONIA (MG/L)	0.020 - 0.040	0.027	0.028	0.004 - 0.126	0.066	0.050	0.038 - 0.188	0.054	0.050
KJEL N (MG/L)	0.280 - 0.580	0.330	0.300	0.400 - 0.880	0.522	0.480	0.480 - 1.080	0.578	0.580
INORG N (MG/L)	0.180 - 0.350	0.235	0.210	0.340 - 0.340	0.286	0.170	0.092 - 0.120	0.104	0.098
TOTAL N (MG/L)	0.870 - 0.930	0.922	0.940	0.480 - 0.920	0.652	0.540	0.620 - 1.020	0.684	0.638
CHLRPHL A (UG/L)	8.6 - 8.5	3.4	8.9	3.2 - 4.2	4.5	4.8	28.8 - 29.5	29.4	29.7
SECCHI (METERS)	1.5 - 2.8	2.1	2.1	0.1 - 1.1	0.5	0.4	1.1 - 1.7	1.2	1.1

A SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR KEMP LAKE
START DATE 4/29

<-> SAMPLING (10/29/74-)

3 SITES

PARAMETER	RANGE	MEAN	MEDIAN
TEMP (C)	17.7 - 18.4	17.9	17.9
DISS OXY (MG/L)	7.8 - 8.6	8.2	8.2
CONDCTVY (MCMHO)	340. - 344.	342.	357.
PH (STAND UNITS)	[illegible]		
TOT ALK (MG/L)	74. - 86.	81.	85.
TOT P (MG/L)	0.025 - 0.033	0.030	0.027
DIS P (MG/L)	0.017 - 0.024	0.020	0.021
NO2+NO3 (MG/L)	0.025 - 0.050	0.044	0.029
AMMONIA (MG/L)	0.029 - 0.050	0.031	0.030
KJEL N (MG/L)	0.300 - 0.700	0.433	0.400
ORG N (MG/L)	0.042 - 0.290	0.098	0.050
TOTAL N (MG/L)	0.320 - 0.730	0.482	0.420
CHLRPYL A (UG/L)	11.1 - 15.8	12.4	12.7
SECCHI (METERS)	0.1 - 1.2	0.7	0.9

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
04/04/74	1. Chroomonas sp.	1,057
	2. Oocystis sp.	88
	Total	1,145
05/13/74	1. Oocystis sp.	674
	2. Centric diatoms	530
	3. Oscillatoria sp.	433
	4. Microcystis sp.	385
	5. Scenedesmus sp.	337
	Other genera	2,454
	Total	4,813
08/08/74	1. Anabaenopsis sp.	10,492
	2. Oscillatoria sp.	2,469
	3. Pennate diatoms	1,234
	4. Oocystis sp.	823
	5. Lyngbya sp.	720
	Other genera	1,440
	Total	17,178
10/28/74	1. Oscillatoria sp.	2,008
	2. Anabaenopsis sp.	1,121
	3. Diplonels sp.	327
	4. Lyngbya sp.	234
	5. Pennate diatoms	187
	Other genera	373
	Total	4,250

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (ug/l)
03/04/74	1	8.5
	2	0.6
	3	6.9
	4	-
06/13/74	1	3.6
	2	6.2
	3	-
	4	4.0
08/08/74	1	18.2
	2	23.5
	3	-
	4	18.0
10/28/74	1	12.7
	2	11.1
	3	-
	4	15.0

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	<0.005	0.118	0.1
0.050 P	<0.055	0.118	1.2
0.050 P + 1.0 N	<0.055	1.118	9.6
1.0 N	<0.005	1.118	0.1

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity

of Lake Kemp was low at the time the assay sample was collected (03/04/74). Also, a significant increase in yield with the addition of phosphorus alone indicates that the lake was phosphorus limited at that time. Note that the addition of nitrogen alone resulted in a yield no greater than that of the control.

The lake data indicate phosphorus limitation in March, May, and August but nitrogen limitation in October (the mean inorganic nitrogen to orthophosphorus ratios were 16 to 1, 24 to 1, 38 to 1, and 4 to 1, respectively).

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Texas National Guard collected monthly near-surface grab samples when possible from each of the tributary sites indicated on the map (page vi), except for the months of April and May when two samples were collected at the inlet. Sampling was begun in September, 1974, and was completed in August, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Texas District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were calculated using mean annual concentrations and mean annual flows. Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the mean concentrations in Wichita River at station A-2 and the mean annual ZZ flow.

No known point sources impacted Lake Kemp during the sampling year.

A. Waste Sources:

1. Known municipal - None

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Wichita River	10,190	83.2
b. Minor tributaries & immediate drainage (non-point load) -	745	6.1
c. Known municipal STP's - None	-	-
d. Septic tanks* -	215	1.8
e. Known industrial - None	-	-
f. Direct precipitation** -	1,090	8.9
Total	12,240	100.0

2. Outputs -

Lake outlet - Wichita River 3,745

3. Net annual P accumulation - 8,495 kg.

* Estimate based on 764 lakeshore dwellings; see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Wichita River	131,070	60.7
b. Minor tributaries & immediate drainage (non-point load) -	9,606	4.4
c. Known municipal STP's - None	-	-
d. Septic tanks* -	8,140	3.8
e. Known industrial - None	-	-
f. Direct precipitation** -	67,120	31.1
Total	215,936	100.0

2. Outputs -

Lake outlet - Wichita River 88,920

3. Net annual N accumulation - 127,015 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Wichita River	3	27

* Estimate based on 764 lakeshore dwellings; see Working Paper No. 175.
** See Working Paper No. 175.

E. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	0.20	0.14	3.5	2.0

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Lake Kemp:

"Dangerous" (eutrophic loading)	0.28
"Permissible" (oligotrophic loading)	0.14

V. LITERATURE REVIEWED

Anonymous, 1976. Water resources data for Texas, water year 1975. Water-Data Rept. TX-75-1. U.S. Geol. Surv., Austin.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE CODE	LAKE NAME	[illegible] TOTAL *	[illegible] [illegible] *	[illegible] [illegible] SEC	[illegible] [illegible]	[illegible] [illegible]	[illegible] [illegible] *
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

LAKE DATA TO BE USED IN ASSIGNMENTS

LAKE CODE	LAKE NAME	[illegible] TOTAL P	[illegible] INORG N	SUR- [illegible] DEC	[illegible] CHLOR	[illegible] ION 10	[illegible] 1055 SAMPLE P
429	[illegible] LAKE	0.052	0.105	473.611	24.491	13.000	0.011
430	[illegible] LAKE	0.071	0.108	482.716	16.457	18.481	0.012
431	[illegible]	0.051	0.108	486.250	3.167	15.886	0.010
432	[illegible] LAKE	0.046	0.108	485.417	18.246	13.200	0.013
433	[illegible] LAKE	0.104	0.123	479.500	19.119	12.448	0.020
434	[illegible] LAKE	0.042	0.108	481.321	12.493	15.488	0.010
435	[illegible] LAKE	0.014	0.059	389.913	5.595	15.886	0.007
436	[illegible]	0.109	0.110	479.500	24.388	10.886	0.040
437	[illegible]	0.025	0.059	484.917	8.788	14.888	0.009
438	[illegible]	0.018	0.108	434.500	4.333	15.886	0.009
439	[illegible] LAKE	0.020	0.120	438.500	6.912	15.886	0.008

14.

[illegible] OF LAKES WITH [illegible] VALUES [illegible] NUMBER OF LAKES IN THE REGION VALUES)

LAKE CODE	LAKE NAME	[illegible] TOTAL P	[illegible] INORG N	SUB- [illegible] SEC	[illegible] CHLOPHA	[illegible] [illegible]	[illegible] [illegible]	[illegible] NU
4001	[illegible] LAKE	45 (36)	5 (2)	188 (58)	188 (36)	35 (14)	43 (23)	46
4002	[illegible] LAKE	76 (30)	74 (29)	62 (31)	47 (18)	17 (0)	62 (34)	343
4003	[illegible] RESERVOIR	62 (35)	26 (10)	99 (37)	68 (26)	17 (0)	84 (31)	394
4004	[illegible] LAKE	5 (2)	42 (16)	58 (19)	8 (3)	48 (17)	5 (2)	159
4005	[illegible] LAKE	76 (25)	78 (26)	29 (11)	67 (33)	58 (22)	84 (31)	394
4006	LAKE [illegible]	47 (18)	21 (7)	74 (28)	63 (24)	17 (0)	79 (34)	261
4007	CADDO LAKE	26 (10)	91 (33)	42 (16)	32 (12)	76 (29)	38 (10)	267
4008	CHANNING LAKE	45 (17)	100 (36)	47 (18)	11 (4)	67 (25)	92 (34)	362
4009	DANTON RESERVOIR	66 (25)	0 (0)	95 (36)	47 (17)	48 (17)	47 (17)	446
4010	LAKE COLEMAN CITY	38 (34)	76 (28)	26 (10)	42 (16)	88 (33)	38 (14)	314
4011	DEPAS DIESEL LAKE	0 (0)	47 (18)	18 (7)	13 (5)	62 (23)	0 (0)	155
4012	[illegible] LAKE	68 (26)	63 (31)	32 (12)	29 (11)	97 (37)	63 (23)	372
4013	EAGLE [illegible] LAKE	72 (27)	91 (33)	34 (13)	79 (30)	79 (30)	76 (28)	428
4014	FT PHANTOM HILL LAKE	24 (9)	68 (25)	21 (8)	74 (28)	95 (36)	16 (6)	298
4015	GARZA LITTLE ELM RESERVO	34 (13)	13 (5)	16 (6)	34 (13)	55 (21)	21 (7)	173
4016	HOOP LAKE	76 (29)	61 (23)	55 (21)	55 (21)	84 (32)	92 (34)	423
4017	[illegible] LAKE	16 (6)	26 (9)	8 (0)	24 (9)	72 (27)	11 (4)	179
4018	LAKE OF THE PINES	54 (20)	76 (28)	66 (25)	39 (15)	17 (0)	46 (17)	248
4019	LAVON RESERVOIR	21 (8)	29 (11)	3 (1)	84 (32)	100 (38)	21 (7)	458
4020	LOVINGTON LAKE	3 (1)	3 (1)	39 (15)	26 (10)	17 (0)	3 (1)	91
4021	LYNDON B JOHNSON LAKE	39 (14)	11 (4)	53 (20)	66 (25)	38 (14)	38 (10)	239
4022	MEDINA LAKE	99 (37)	0 (0)	69 (26)	37 (14)	17 (0)	100 (38)	342
4023	LAKE [illegible]	82 (30)	91 (33)	71 (27)	95 (36)	38 (14)	63 (23)	441
4024	PALESTINE LAKE	54 (20)	32 (12)	63 (24)	53 (20)	48 (17)	51 (19)	362
4025	[illegible] RESERVOIR	74 (26)	91 (33)	84 (32)	96 (22)	17 (0)	63 (23)	347
4026	SAN ANGELO RESERVOIR	12 (5)	45 (17)	6 (2)	8 (0)	88 (33)	46 (17)	450
4027	SAN [illegible] RESERVOIR	59 (22)	26 (15)	68 (26)	76 (29)	17 (0)	63 (23)	322
4028	E O SPENCE RESERVOIR	58 (19)	63 (31)	45 (17)	58 (14)	17 (0)	76 (28)	321

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	[illegible] TOTAL P	[illegible] ZINC %	[illegible] MOLY UG/	[illegible] CHLORA	[illegible] 400 UG	[illegible] 0.015 UG/L P	[illegible] MG
429	SOMERVILLE LAKE	29 (110)	55 (210)	24 (91)	3 (11)	67 (254)	38 (145)	254
430	STAMFORD LAKE	18 (70)	47 (177)	5 (21)	18 (71)	82 (312)	39 (148)	259
431	STILLHOUSE HOLLOW RESERVOIR	69 (233)	37 (140)	67 (339)	92 (350)	17 (64)	51 (194)	372
432	TAWAKONI LAKE	32 (121)	78 (294)	37 (140)	23 (87)	83 (244)	32 (121)	253
433	TEHUACANA LAKE	11 (42)	51 (194)	13 (50)	16 (61)	72 (273)	13 (50)	178
434	TEXANA LAKE	35 (134)	34 (129)	61 (229)	45 (171)	17 (64)	21 (71)	217
435	TWIN LAKE	68 (259)	21 (79)	42 (159)	82 (311)	17 (64)	84 (317)	384
436	TWOMILE	0 (0)	61 (231)	11 (42)	5 (21)	42 (159)	0 (0)	169
437	TWIN WATER RESERVOIR	59 (223)	21 (79)	58 (221)	61 (233)	66 (171)	63 (239)	311
438	WHITE HOUSE RESERVOIR	84 (320)	55 (209)	76 (289)	89 (340)	17 (64)	63 (239)	346
439	WHITNEY LAKE	63 (240)	51 (194)	76 (289)	71 (271)	17 (64)	76 (288)	257

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]
8	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]
11	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	[illegible]
13	[illegible]	[illegible]	[illegible]
14	[illegible]	[illegible]	[illegible]
15	[illegible]	[illegible]	[illegible]
16	[illegible]	[illegible]	[illegible]
17	[illegible]	[illegible]	[illegible]
18	[illegible]	[illegible]	[illegible]
19	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	[illegible]
21	[illegible]	[illegible]	[illegible]
22	[illegible]	[illegible]	[illegible]
23	[illegible]	[illegible]	[illegible]
24	[illegible]	[illegible]	[illegible]
25	[illegible]	[illegible]	[illegible]
26	[illegible]	[illegible]	[illegible]
27	[illegible]	[illegible]	[illegible]
28	[illegible]	[illegible]	[illegible]

LAKES RANKED BY [illegible]

[illegible]	LAKE CODE	LAKE NAME	[illegible]
29	403	LYNDA B JOHNSON LAKE	239
30	404	TEXAS LAKE	217
31	405	SOMERVILLE LAKE	204
32	406	SAN ANGELO RESERVOIR	200
33	407	TEXARKANA LAKE	176
34	408	BIRCH LITTLE ELM RESERVOIR	173
35	409	TEXOMA	164
36	410	BRIANS LAKE	154
37	411	CORPUS CHRISTI LAKE	155
38	412	HOUSTON LAKE	139
39	413	LIVINGSTON LAKE	96

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107 x 10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

APPENDIX D

PHYSICAL and CHEMICAL DATA

[illegible]

[illegible]

[illegible]
[illegible]
[illegible]

[illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	15	15	[illegible]	12.2		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	15	15	[illegible]	22.1	36.2		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	15	15	[illegible]	5.8[illegible]	6.[illegible]
	15	15	[illegible]	5.8[illegible]	

[illegible] REGIONAL DATE 74/10/13

[illegible]
33 46 56.6 099 17 25.0
[illegible] LAKE
[illegible] TEXAS

13EPALES 211262
3 [illegible] FEET DEPT-

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FROM	HR		TEMP		SECCHI	CHEMICAL	[illegible]	T ALK	CHLOR	TOT KJEL	[illegible]	[illegible]	[illegible]
TO	DAY	-1157	DENT	[illegible]	INCHES	[illegible]	SU	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L P
74/05/13	11	-1	0748	23.4		17	4	8.35	85	0.678	0.788	0.156	0.009
	12	-1	1005	23.3	7.8		4	8.48	84	0.683	0.488	0.134	0.388
	13	46	0815	23.2	7.9		4	8.48	84	0.696	0.588	0.148	0.888
	13	46	0823	23.6	7.4		4	8.35	85	0.648	0.488	0.118	0.896
74/08/08	14	25	0808	27.1	7.8	45	5642	7.98	85	0.858	0.788	0.488	0.882
	14	25	0825	27.2			5618	8.46					
	14	25	0913	28.9	7.8		5398	8.38	83	0.858	0.488	0.428	0.882K
	14	25	0821	28.1	6.9		5268	8.25	85	0.846	0.588	0.426	0.882K
74/10/29	14	25	0808	17.9	8.5	36	3457		85	0.828K	0.488	0.428K	0.838
	14	25	0805	17.6	8.5		3453		85	0.828	0.388	0.428	0.817
	14	25	0815	17.7	8.9		3432		82	0.827K	0.388	0.428K	0.821

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]
FROM	OF		MG/L-TOT	CHLOROPHYL	INCUT LT
TO	DAY	FEET	MG/L P	A	PENETRATION PERCENT
74/05/13	13	46	0808	0.029	4.8
	13	46	0805	0.023	
	13	46	0815	0.029	
	13	46	0823	0.038	
74/08/08	14	25	0808	0.029	16.8
	14	25	0813	0.025	
	14	25	0821	0.046	
74/10/29	14	25	0808	0.025	15.8
	14	25	0805	0.029	
	14	25	0815	0.027	

* VALUE FROM TO BE
LESS THAN INDICATED

APPENDIX E

TRIBUTARY DATA

[illegible]

[illegible]

DATE	TIME	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FROM	OF		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TO	DAY	FEET	MG/L	MG/L	MG/L	MG/L P	MG/L P
[illegible]	[illegible]		0.632	0.488	[illegible]	0.805	0.839
[illegible]	[illegible]		0.844	0.498	0.805	0.805	0.840
[illegible]	[illegible]		0.858	1.488	0.829	0.825	
[illegible]	[illegible]		0.856	0.883	0.868	0.839	0.838
[illegible]	[illegible]		0.875	0.858	0.838	0.885	0.828
[illegible]	[illegible]		0.838	0.886	0.835	0.89[illegible]	0.858
[illegible]	[illegible]		0.828	0.788	0.825	0.8854	0.838
[illegible]	[illegible]		0.885	0.758	0.825	0.889[illegible]	0.840

* VALUE FROM TO BE
LESS THAN INDICATED.

[illegible]

[illegible]

DATE	TIME	DEPTH	89030	89825	89830	89871	89905
FROM	OF	OF	[illegible]	TOT [illegible]	[illegible]	[illegible]	[illegible]
TO	DAY	FEET	MPN	MPN	MPN	MPN, P	MPN, P
[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

< VALUE KNOWN TO BE
LESS THAN INDICATED